REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	30 October 1994	Final 2/1/92-9/30/94

4. TITLE AND SUBTITLE

Robust Fixed-Structure Control

5. FUNDING NUMBERS

F49620-92-J-0127

6. AUTHOR(S)

Dennis S. Bernstein

AFOSR-TR- 95 - 0202

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

The University of Michigan
Department of Aerospace Engineering
1320 Beal Ave
Ann Arbor, MI 48109-2118

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Air Force Office of Scientific Research
AFOSR/PKA
110 Duncan Ave, Suite B115
Bolling AFB, DC 20332-0001

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

F49620-92-J-0127

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT

Unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

This final report for AFOSR Grant F49620-92-J-0127 summarizes results obtained in five areas, namely, robust control, linear control, sampled-data control, tracking and disturbance rejection, and nonlinear control. Principal results include new bounds for the structured singular value, implementation of structured singular value synthesis using fixed-structure optimization techniques, a more rigorous foundation for the Maximum Entropy control technique, extensions of linear-quadratic control to stable stabilizing controllers, determination of the achievable performance of sampled-data controllers in the presence of sample-rate constraints, control of noise in an acoustic duct, stability theory for second-order systems, a rigorous treatment of Guyan reduction, a deterministic foundation for energy flow theory, a unified treatment of quadratic optimality and servocompensation, nonlinear control of the spinning top and rotating bodies with known and unknown mass imbalance, global stabilization of the oscillating eccentric rotor using integrator backstepping, and Lyapunov theory for finite-time convergence.

14. SUBJECT TERMS

feedback control, robustness, nonlinear systems, dynamics

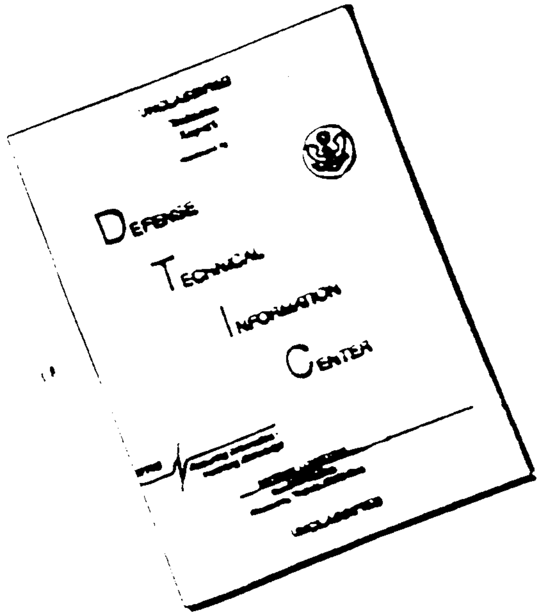
15. NUMBER OF PAGES

24

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	None

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

Robust, Fixed-Structure Control

Final Report

Air Force Office of Scientific Research
Grant F49620-92-J-0127

Program Manager:

Dr. Marc Q. Jacobs

Accesion For		
NTIS CRA&I		X
DTIC TAB		☐
Unannounced		☐
Justification		
By		
Distribution /		
Availability Codes		
Dist	Avail and / or Special	
A-1		

Principal Investigator:

Dennis S. Bernstein
Department of Aerospace Engineering
The University of Michigan
Ann Arbor, MI 48109-2118
313 764-3719
dsbaero@engin.umich.edu

October 27, 1994

1. Introduction

This Final Report marks the end of the third year of the 3-year cycle of AFOSR Grant F49620-92-J-0127. The first year of the Grant encompassed the period February 1992 to October 1992, the second year encompassed the period November 1992 through October 1993, and the third year encompassed the period November 1993 to September 1994. Research results from the first two periods are summarized in the Annual Reports dated November 1992 and November 1993. In this report we summarize results obtained throughout the entire program.

Attached to this report in Appendix A is a comprehensive bibliography listing all publications of the Principal Investigator. Part I covers journal papers and book chapters, while Part II covers conference publications. This list includes published papers, papers in press (denoted "to appear"), and papers submitted for publication. All of the listed papers corresponding to the time period of this grant, including papers submitted but not yet published, were supported at least partially by this grant.

Many of the results reported herein were obtained in collaboration with graduate student researchers at the University of Michigan some of whom were supported at varying levels under this Grant.

The outline of this proposal follows the original proposal which focused on five areas of research, namely, robust control, linear control, sampled-data control, tracking and disturbance rejection, and nonlinear control. Principal results include new bounds for the structured singular value, implementation of structured singular value synthesis using fixed-structure optimization techniques, a more rigorous foundation for the Maximum Entropy control technique, extensions of linear-quadratic control to stable stabilizing controllers, determination of the achievable performance of sampled-data controllers in the presence of sample-rate constraints, control of noise in an acoustic duct, stability theory for second-order systems, a rigorous treatment of Guyan reduction, a deterministic foundation for energy flow theory, a unified treatment of quadratic optimality and servocompensation, nonlinear control of the spinning top and rotating bodies with known and unknown mass imbalance, global stabilization of the oscillating eccentric rotor using integrator backstepping, and Lyapunov theory for finite-time convergence. These results are described in more detail in the following sections.

2. Summary of Technical Results

2.1 Robust Control

The major emphasis of this project was on robust control due to its relevance to control engineering applications. Our main line of work in this area has moved progressively from H_∞ theory, to positive real theory, to circle theory, to Popov theory, and, finally, to mu theory. After applying Popov-type theory to robust controller synthesis [I.91], we explored ties between structured singular value theory and classical absolute stability [I.81] which addresses the problems of nonlinear uncertainty and robust H_2 performance.

When used in the context of fixed-structure controller synthesis, the generalized Popov results provide an alternative to structured singular value synthesis by offering advantages over traditional D-K iteration. Specifically, by exploiting the cost gradients with respect to the parameterization of the multipliers, the controller, which may be of arbitrary fixed structure, can be determined concurrently with the multipliers. Although,

as with D-K iteration, it is not yet possible to prove convergence, the coupling of the controller and multiplier steps provides the possibility of significantly more efficient computational approaches [I.107,I.115,I.116].

An alternative approach to robust control with constant real parameters is given by recent results obtained in [I.93]. In this paper we developed a novel frequency domain criterion that is distinct from structured singular value and absolute stability theory (such as Popov theory). Specifically, whereas structured singular value and absolute stability theory are based upon frequency-dependent circles in the Nyquist plane to guarantee robust stability, this new test guarantees stability by excluding the Nyquist plot from a *parabolic* region. For the case of two-sided uncertainty as in standard structured singular value and Popov theory, this condition has the form of a novel octomorphic (figure-eight shaped) inclusion criterion. Variations of this approach are explored in [II.130].

The advantage of the octomorphic criterion over standard structured singular value bounds is the fact that, due to its shape, the region is able to encompass the entire Nyquist plot. Thus it is not necessary as with circles to vary the region with frequency. Consequently, the scales needed to account for the multiple-block structure of the uncertainty are not required to be frequency dependent. This feature may allow considerable simplification in the implementation of real structured singular value bounds.

2.2 Linear Control

The fixed-structure approach has been used to synthesize linear controllers within the framework established by our robust control results as well as other design criteria. The fixed-structure approach provides considerable flexibility for synthesizing controllers of a desired feedback architecture, including order and decentralization. Although this approach does not lend itself easily to existence questions, it provides constructive techniques for obtaining controllers of interest. In contrast, conventional methods yield controllers only in special cases having more limited practical value.

In recent work we have addressed the problem of designing suboptimal controllers that are stable [I.83.I.86,I.87]. These results seek to overcome one of the drawbacks of optimal control techniques that may yield unstable controllers. Such unstable controllers are viewed by control-system practitioners as potentially dangerous for real-world applications. Our recent results offer significant improvements over earlier results we obtained in [I.51,II.48]. For example, the performance penalty for obtaining stable controllers has been reduced, and the new results yield reduced-order controllers as well.

Additional fixed-structure results motivated by practical issues are our results on designing positive real controllers [I.76]. These results, which extend an idea of other researchers to H_2/H_∞ control, allow the designer to obtain positive real controllers for flexible structure applications [I.96.I.111] where the sensors and actuators are colocated and dual. Since positive real controllers are also stable, these results are a refinement of the stable controllers mentioned above to a special class of problems. As an application of these positive real controllers, we developed an energy flow theory in [I.88.I.89.I.95] and used the positive real control approach to design energy flow controllers in [I.99.I.100].

To numerically implement these fixed-structure results, we have developed numerical optimization techniques. Two approaches have been considered. The first is a homotopy-based method being developed jointly with Professor L. T. Watson of Virginia Tech [I.60.I.61.I.98]. A parallel effort at the University of Michigan is based upon quasi-

Newton algorithms. To produce a reliable and widely applicable software package, we utilize the UNCMND package interfaced with Matlab routines. This code is being tested using laboratory data from a noise control experiment.

The code developed thus far applies to a general decentralized output feedback problem for H_2 and H_2/H_∞ controller synthesis. This code has been merged with the homotopy code developed at Virginia Tech to produce a more complete control design package. Extensions to structured singular value [I.116] and Maximum Entropy control design [I.66,I.90] are being developed.

2.3 Sampled-Data Control

Since modern controllers are usually implemented digitally, one of our goals has been to develop techniques for designing controllers that account precisely for sampling and discretization effects. Three topics in this area have been explored in recent work.

In [I.74] we explored problems that are inherent in designing sampled-data estimators for unstable plants. The main result is that the estimation cost is infinite unless the signal reconstruction device is a generalized hold extrapolator. This result thus focuses on a fundamental limitation of sampled-data systems.

In [I.79] we applied a periodic fixed-order approach to the problem of multi-rate estimation. This approach appears to be simpler and more straightforward than alternative approaches based upon lifting of the state space. More recently, the multi-rate control problem has been addressed using the fixed-order approach by Haddad and Kapila.

In [I.94] we carefully examined the dependence of achievable performance as a function of sample rate. By accounting precisely for all A/D and D/A effects as well as the discretization of the measurement noise, we were able to design a collection of controllers that range from continuous-time (infinitely fast sampling) to open-loop (infinitely slow sampling). These results demonstrate for the first time how the sampling rate affects the achievable closed-loop performance.

Finally, the use of exponential hold devices was examined in [II.118], while sampled-data control in the presence of transport delays was considered in [II.120].

2.4 Tracking and Disturbance Rejection

An important problem of practical interest involves tracking and disturbance rejection problems under various assumptions on the command and disturbance signals. The motivation behind this research is to improve system performance by exploiting specific knowledge concerning these signals. For example, a common control strategy is to employ internal models within the feedback controller to achieve asymptotic command following or disturbance rejection. This approach is called servocompensation and disturbance accommodation.

Thus far we have merged H_2 theory with servocompensator design to examine fundamental tradeoffs between these two objectives [I.103]. Dual results for disturbance accommodation follow analogously [I.105,I.106]. In both cases we apply fixed-structure optimization techniques to determine optimal controller gains.

Work in progress in this area includes adaptive tracking and disturbance accommodation of partially uncertain signals such as sinusoids with uncertain frequency. This work extends the servocompensation theory which allows uncertain phase and amplitude, but requires precise knowledge of frequency.

2.5 Nonlinear Control

As linear control theory becomes increasingly well-understood, there remains the challenge of designing nonlinear controllers that can improve performance beyond the best linear controllers. In fact, most implemented controllers are actually nonlinear due to mode switching and other effects. Hence, a major area of emphasis of this program has been the development of nonlinear control methods that are applicable to problems of engineering interest. Our main goal is to develop control methods that have sufficiently broad applicability to address real world constraints and models.

The results we have obtained thus far exploit the relationship between Lyapunov function theory and Hamilton-Jacobi-Bellman theory. In particular, by focusing on steady-state problems, we exploit the fact that the solution to the HJB equation is a Lyapunov function for the closed-loop system [I.68]. The key step is to exploit the relationship between the cost functional, the Lyapunov function, and the plant dynamics. In certain cases, families of nonlinear feedback control laws can be found as solutions to the HJB equation. This approach was used in [I.92] to obtain a class of nonlinear control laws that globally stabilize angular velocity with only two torque actuators. These results include controllers obtained by other researchers as special cases and showed, for the first time, that the zero dynamics structure plays a role in finding solutions to the HJB equation.

As another application of HJB theory, we considered in [I.85] the problem of feedback control with multiple saturating actuators. For this practical problem, we showed that continuous saturating nonlinear control laws are optimal for a modified cost functional having different definitions in the nonsaturating and saturating regions. These results are an improvement over known results involving discontinuous controllers.

In related results concerning the saturation problem, we obtained novel results pertaining to a wide class of input nonlinearities, including saturation as a special case [I.78]. These results are valid for the limited, but practical, class of positive real plants subjected to positive real controllers. By using a nonlinear modification of the controller, we showed using Lyapunov methods that the closed-loop system can be guaranteed to be stable in spite of the input nonlinearity. This approach was demonstrated for the problem of integrator windup which arises with PI controllers. By suppressing integrator windup, the nonlinear controller is less prone to the effects of actuator saturation. This approach appears to be the first anti-windup scheme that is based upon Lyapunov stability theory.

Further results on control of plants with saturation were obtained in [I.104] which applied small-gain type techniques to guarantee closed-loop stability. A novel feature of these results is the elimination of a priori assumptions on the amplitude of the state or magnitude of control. A modified Lyapunov-type argument was used to guarantee stability without excessive conservatism.

Nonlinear controllers were obtained for a challenging nonlinear mechanical system known as the oscillating eccentric rotor. Stabilizing controllers were obtained by applying integrator backstepping techniques [I.109]. The performance of these controllers and the required control effort were compared to the use of passive controllers in [II.108]. This comparison uses insight obtained from our work on energy flow theory [I.88,I.89,I.95].

As another challenging problem in nonlinear control, we considered the control of the spinning top under a variety of actuation schemes [I.97,I.101]. More recently, we considered the case in which the top is asymmetric and/or possesses mass imbalance [I.113]. This work provided the basis for considering the practical problem of stabilizing a rotating body with unknown mass imbalance [I.114].

Finally, we studied a class of nonlinear controllers having the property of driving the state to the origin in finite time [II.122]. These controllers are of interest in practical situations involving mechanical contact without collision.

Appendix A

Publications of the Principal Investigator

Appendix A

Publications of the Principal Investigator

I. Journal Papers and Book Chapters

I.1 D. S. Bernstein, "The Treatment of Inputs in Real-Time Digital Simulation," *Simulation*, Vol. 33, No. 2, pp. 65–68, 1979.

I.2 D. S. Bernstein and E. G. Gilbert, "Optimal Periodic Control: The Pi Test Revisited," *IEEE Trans. Autom. Contr.*, Vol. AC-25, pp. 673–684, 1980.

I.3 E. G. Gilbert and D. S. Bernstein, "Second-Order Necessary Conditions in Optimal Control: Accessory-Problem Results Without Normality Conditions," *J. Optim. Thy. Appl.*, Vol. 41, pp. 75–106, 1983.

I.4 D. S. Bernstein, "A Systematic Approach to Higher-Order Necessary Conditions in Optimization Theory," *SIAM J. Contr. Optim.*, pp. 211–238, 1984.

I.5 D. C. Hyland and D. S. Bernstein, "The Optimal Projection Equations for Fixed–Order Dynamic Compensation," *IEEE Trans. Autom. Contr.*, Vol. AC–29, pp. 1034-1037, 1984.

I.6 D. S. Bernstein, "Control Constraints, Abnormality, and Improved Performance by Periodic Control," *IEEE Trans. Autom. Contr.*, Vol. AC-30, pp. 367-376, 1985.

I.7 D. S. Bernstein and D. C. Hyland, "The Optimal Projection Equations for Reduced-Order State Estimation," *IEEE Trans. Autom. Contr.*, Vol. AC-30, pp. 583–585, 1985.

I.8 D. C. Hyland and D. S. Bernstein, "The Optimal Projection Equations for Model Reduction and the Relationships Among the Methods of Wilson, Skelton and Moore," *IEEE Trans. Autom. Contr.*, Vol. AC–30, pp. 1201–1211, 1985.

I.9 D. S. Bernstein and D. C. Hyland, "The Optimal Projection Equations for Finite-Dimensional Fixed-Order Dynamic Compensation of Infinite-Dimensional Systems," *SIAM J. Contr. Optim.*, Vol. 24, pp. 122–151, 1986.

I.10 D. S. Bernstein and S. W. Greeley, "Robust Controller Synthesis Using the Maximum Entropy Design Equations," *IEEE Trans. Autom. Contr.*, Vol. AC–31, pp. 362–364, 1986.

I.11 D. S. Bernstein, L. D. Davis, and D. C. Hyland, "The Optimal Projection Equations for Reduced-Order, Discrete-Time Modelling, Estimation and Control," *AIAA J. Guid. Contr. Dyn.*, Vol. 9, pp. 288–293, 1986.

I.12 D. S. Bernstein, L. D. Davis, and S. W. Greeley, "The Optimal Projection Equations for Fixed-Order, Sampled-Data Dynamic Compensation with Computation Delay," *IEEE Trans. Autom. Contr.*, Vol. AC–31, pp. 859–862, 1986.

I.13 W. M. Haddad and D. S. Bernstein, "The Optimal Projection Equations for Discrete-Time Reduced-Order State Estimation for Linear Systems with Multiplicative White Noise," *Sys. Contr. Lett.*, Vol. 8, pp. 381–388, 1987.

I.14 D. S. Bernstein and W. M. Haddad, "Optimal Output Feedback for Nonzero Set Point Regulation," *IEEE Trans. Autom. Contr.*, Vol. AC–32, pp. 641–645, 1987.

I.15 D. S. Bernstein and W. M. Haddad, "Optimal Projection Equations for Discrete-Time Fixed-Order Dynamic Compensation of Linear Systems with Multiplicative White Noise," *Int. J. Contr.*, Vol. 46, pp. 65–73, 1987.

I.16 D. C. Hyland and D. S. Bernstein, "The Majorant Lyapunov Equation: A Nonnegative Matrix Equation for Guaranteed Robust Stability and Performance of Large Scale Systems," *IEEE Trans. Autom. Contr.*, Vol. AC–32, pp. 1005–1013, 1987.

I.17 D. S. Bernstein, "Sequential Design of Decentralized Dynamic Compensators Using the Optimal Projection Equations," *Int. J. Contr.*, Vol. 46, pp. 1569–1577, 1987.

I.18 D. S. Bernstein, "Robust Static and Dynamic Output-Feedback Stabilization: Deterministic and Stochastic Perspectives," *IEEE Trans. Autom. Contr.*, Vol. AC–32, pp. 1076–1084, 1987.

I.19 W. M. Haddad and D. S. Bernstein, "The Optimal Projection Equations for Reduced-Order State Estimation: The Singular Measurement Noise Case," *IEEE Trans. Autom. Contr.*, Vol. AC–32, pp. 1135–1139, 1987.

I.20 D. S. Bernstein, "The Optimal Projection Equations for Static and Dynamic Output Feedback: The Singular Case," *IEEE Trans. Autom. Contr.*, Vol. AC–32, pp. 1139-1143, 1987.

I.21 W. M. Haddad and D. S. Bernstein, "Robust, Reduced-Order, Nonstrictly Proper State Estimation via the Optimal Projection Equations with Petersen-Hollot Bounds," *Sys. Contr. Lett.*, Vol. 9, pp. 423–431, 1987.

I.22 W. M. Haddad and D. S. Bernstein, "Optimal Output Feedback for Nonzero Set Point Regulation: The Discrete-Time Case," *Int. J. Contr.*, Vol. 47, pp. 529–536, 1988.

I.23 W. M. Haddad and D. S. Bernstein, "The Unified Optimal Projection Equations for Simultaneous Reduced-Order, Robust Modeling, Estimation and Control," *Int. J. Contr.*, Vol. 47, pp. 1117–1132, 1988.

I.24 D. S. Bernstein, "Inequalities for the Trace of Matrix Exponentials," *SIAM J. Matrix Anal. Appl.*, Vol. 9, pp. 156–158, 1988.

I.25 D. S. Bernstein and W. M. Haddad, "The Optimal Projection Equations with Petersen-Hollot Bounds: Robust Stability and Performance via Fixed-Order Dynamic Compensation for Systems with Structured Real-Valued Parameter Uncertainty," *IEEE Trans. Autom. Contr.*, Vol. 33, pp. 578–582, 1988.

I.26 W. M. Haddad and D. S. Bernstein, "Robust, Reduced-Order, Nonstrictly Proper State Estimation via the Optimal Projection Equations with Guaranteed Cost Bounds," *IEEE Trans. Autom. Contr.*, Vol. 33, pp. 591–595, 1988.

I.27 W. M. Haddad and D. S. Bernstein, "Robust, Reduced-Order Modeling via the Optimal Projection Equations with Petersen-Hollot Bounds," *IEEE Trans. Autom. Contr.*, Vol. 33, pp. 692–695, 1988.

I.28 W. M. Haddad and D. S. Bernstein, "Optimal Nonzero Set Point Regulation via Fixed-Order Dynamic Compensation," *IEEE Trans. Autom. Contr.*, Vol. 33, pp. 848–852, 1988.

I.29 D. S. Bernstein and D. C. Hyland, "Optimal Projection Equations for Reduced-Order Modelling, Estimation and Control of Linear Systems with Multiplicative White Noise," *J. Optim. Thy. Appl.*, Vol. 58, pp. 387–409, 1988.

I.30 D. S. Bernstein and D. C. Hyland, "Optimal Projection for Uncertain Systems (OPUS): A Unified Theory of Reduced-Order, Robust Control Design," in *Large Space Structures: Dynamics and Control*, S. N. Atluri and A. K. Amos, Eds., pp. 263–302, Springer-Verlag, New York, 1988.

I.31 D. S. Bernstein and W. M. Haddad, "Steady-State Kalman Filtering with an H_∞ Error Bound," *Sys. Contr. Lett.*, Vol. 12, pp. 9–16, 1989.

I.32 D. S. Bernstein and W. M. Haddad, "LQG Control With an H_∞ Performance Bound: A Riccati Equation Approach," *IEEE Trans. Autom. Contr.*, Vol. 34, pp. 293–305, 1989.

I.33 D. S. Bernstein, "Robust Stability and Performance via Fixed-Order Dynamic Compensation," *SIAM J. Contr. Optim.*, Vol. 27, pp. 389–406, 1989.

I.34 W. M. Haddad and D. S. Bernstein, "Combined L_2/H_∞ Model Reduction," *Int. J. Contr.*, Vol. 49, pp. 1523–1535, 1989.

I.35 D. S. Bernstein and W. M. Haddad, "Robust Stability and Performance Analysis for Linear Dynamic Systems," *IEEE Trans. Autom. Contr.*, Vol. 34, pp. 751–758, 1989.

I.36 D. S. Bernstein and W. M. Haddad, "Robust Decentralized Static Output Feedback," *Sys. Contr. Lett.*, Vol. 12, pp. 309–318, 1989.

I.37 A. N. Madiwale, W. M. Haddad, and D. S. Bernstein, "Robust H_∞ Control Design for Systems with Parameter Uncertainty," *Sys. Contr. Lett.*, Vol. 12, pp. 393–407, 1989.

I.38 D. S. Bernstein and C. V. Hollot, "Robust Stability for Sampled-Data Control Systems," *Sys. Contr. Lett.*, Vol. 13, pp. 217–226, 1989.

I.39 D. S. Bernstein and W. M. Haddad, "Optimal Reduced-Order State Estimation for Unstable Plants," *Int. J. Contr.*, Vol. 50, pp. 1259–1266, 1989.

I.40 W. M. Haddad and D. S. Bernstein, "Optimal Reduced-Order Subspace-Observer Design With a Frequency-Domain Error Bound," in *Advances in Control and Dynamic Systems*, Vol. 2, Part 2, pp. 23–38, C. T. Leondes, Ed., Academic Press, 1990.

I.41 W. M. Haddad and D. S. Bernstein, "On the Gap Between H_2 and Entropy Performance Measures in H_∞ Control," *Sys. Contr. Lett.*, Vol. 14, pp. 113–120, 1990.

I.42 D. S. Bernstein and I. G. Rosen, "Finite-Dimensional Approximation for Optimal Fixed-Order Compensation of Distributed Parameter Systems," *Opt. Contr. Appl. Meth.*, Vol. 11, pp. 1–20, 1990.

I.43 D. S. Bernstein and W. M. Haddad, "Robust Stability and Performance via Fixed-Order Dynamic Compensation with Guaranteed Cost Bounds," *Math. Contr. Sig. Sys.*, Vol. 3, pp. 139–163, 1990.

I.44 D. S. Bernstein and W. M. Haddad, "Robust Stability and Performance Analysis for State Space Systems via Quadratic Lyapunov Bounds," *SIAM J. Matrix Anal. Appl.*, Vol. 11, pp. 239–271, 1990.

I.45 W. M. Haddad and D. S. Bernstein, "Generalized Riccati Equations for the Full- and Reduced-Order Mixed-Norm H_2/H_∞ Standard Problem," *Sys. Contr. Lett.*, Vol. 14, pp. 185–197, 1990.

I.46 D. S. Bernstein and D. C. Hyland, "Optimal Projection Approach to Robust, Fixed-Structure Control Design," in *Mechanics and Control of Large Flexible Structures*, pp. 237–293, J. L. Junkins, Ed., AIAA, 1990.

I.47 W. M. Haddad and D. S. Bernstein, "Optimal Reduced-Order Observer-Estimators," *AIAA J. Guid. Contr. Dyn.*, Vol. 13, pp. 1126–1135, 1990.

I.48 W. M. Haddad, D. S. Bernstein, and D. Mustafa, "Mixed-Norm H_2/H_∞ Regulation and Estimation: The Discrete-Time Case," *Sys. Contr. Lett.*, Vol. 16, pp. 235–248, 1991.

I.49 W. M. Haddad and D. S. Bernstein, "Robust Stabilization with Positive Real Uncertainty: Beyond the Small Gain Theorem," *Sys. Contr. Lett.*, Vol. 17, pp. 191-208, 1991.

I.50 D. Mustafa and D. S. Bernstein, "LQG Bounds in Discrete-Time H_2/H_∞ Control," *Trans. Inst. Meas. Contr.*, Vol. 13, pp. 269-275, 1991.

I.51 Y. Halevi, D. S. Bernstein, and W. M. Haddad, "On Stable Full-Order and Reduced-Order LQG Controllers," *Optimal Contr. Appl. Meth.*, Vol. 12, pp. 163-172, 1991.

I.52 W. M. Haddad and D. S. Bernstein, "Controller Design with Regional Pole Constraints," *IEEE Trans. Autom. Contr.*, Vol. 37, pp. 54-69, 1992.

I.53 D. S. Bernstein and W. M. Haddad, "Robust Controller Synthesis Using Kharitonov's Theorem," *IEEE Trans. Autom. Contr.*, Vol. 37, pp. 129-132, 1992.

I.54 D. S. Bernstein, "Some Open Problems in Matrix Theory Arising in Linear Systems and Control," *Lin. Alg. Appl.*, Vol. 162-164, pp. 409-432, 1992.

I.55 W. M. Haddad, D. S. Bernstein, H.-H. Huang, and Y. Halevi, "Fixed-Order Sampled-Data Estimation," *Int. J. Contr.*, Vol. 55, pp. 129-139, 1992.

I.56 D. S. Bernstein, W. M. Haddad, and D. C. Hyland, "Small Gain Versus Positive Real Modeling of Real Parameter Uncertainty," *AIAA J. Guid. Contr. Dyn.*, Vol. 15, pp. 538-540, 1992.

I.57 B. Wie and D. S. Bernstein, "Benchmark Problems for Robust Control Design," *AIAA J. Guid. Contr. Dyn.*, Vol. 15, pp. 1057-1059, 1992.

I.58 E. G. Collins, Jr., J. A. King, and D. S. Bernstein, "Application of Maximum Entropy/Optimal Projection Design Synthesis to the Benchmark Problem," *AIAA J. Guid. Contr. Dyn.*, Vol. 15, pp. 1094-1102, 1992.

I.59 D. S. Bernstein, "Review of *Minimum Entropy H_∞ Control*," *IEEE Trans. Autom. Contr.*, Vol. 37, pp. 1276-1277, 1992.

I.60 D. Zigic, L. T. Watson, E. G. Collins, Jr., and D. S. Bernstein, "Homotopy Methods for Solving the Optimal Projection Equations for the H_2 Reduced Order Model Problem," *Int. J. Contr.*, Vol. 56, pp. 173-191, 1992.

I.61 D. Zigic, L. T. Watson, E. G. Collins, Jr., and D. S. Bernstein, "Homotopy Approaches to the H_2 Reduced Order Model Problem," *J. Math. Sys. Est. Contr.*, Vol. 3, pp. 173-205, 1993.

I.62 W. M. Haddad, H.-H. Huang, and D. S. Bernstein, "Robust Stability and Performance via Fixed-Order Dynamic Compensation: The Discrete-Time Case," *IEEE Trans. Autom. Contr.*, Vol. 38, pp. 776-782, 1993.

I.63 Y. Halevi, W. M. Haddad, and D. S. Bernstein, "A Riccati Equation Approach to the Singular LQG Problem," *Automatica*, Vol. 29, pp. 773-778, 1993.

I.64 Y. W. Wang and D. S. Bernstein, "Controller Design With Regional Pole Constraints: Hyperbolic and Horizontal Strip Regions," *AIAA J. Guid. Contr. Dyn.*, Vol. 16, pp. 784-787, 1993.

I.65 D. S. Bernstein and D. C. Hyland, "Compartmental Modeling and Second-Moment Analysis of State Space Systems," *SIAM J. Matrix Anal. Appl.*, Vol. 14, pp. 880-901, 1993.

I.66 D. S. Bernstein, W. M. Haddad, D. C. Hyland, and F. Tyan, "Maximum Entropy-Type Lyapunov Functions for Robust Stability and Performance Analysis," *Sys. Contr. Lett.*, Vol. 21, pp. 73-87, 1993.

I.67 D. S. Bernstein and W. So, "Some Explicit Formulas for the Matrix Exponential," *IEEE Trans. Autom. Contr.*, Vol. 38, pp. 1228-1232, 1993.

I.68 D. S. Bernstein, "Nonquadratic Cost and Nonlinear Feedback Control," *Int. J. Robust and Nonlinear Control*, Vol. 3, pp. 211-229, 1993.

I.69 Y. W. Wang and D. S. Bernstein, "H_2 Optimal Control With an α-Shifted Pole Constraint," *Int. J. Contr.*, Vol. 58, pp. 1201-1214, 1993.

I.70 W. M. Haddad and D. S. Bernstein, "Explicit Construction of Quadratic Lyapunov Functions for the Small Gain, Positivity, Circle, and Popov Theorems and Their Application to Robust Stability, Part I: Continuous-Time Theory," *Int. J. Robust and Nonlinear Control*, Vol. 3, pp. 313-339, 1993.

I.71 S. R. Hall, D. G. MacMartin, and D. S. Bernstein, "Covariance Averaging in the Analysis of Uncertain Systems," *IEEE Trans. Autom. Contr.*, Vol. 38, pp. 1858-1862, 1993.

I.72 W. M. Haddad, E. G. Collins, Jr., and D. S. Bernstein, "Robust Stability Analysis Using the Small Gain, Circle, Positivity, and Popov Theorems: A Comparative Study," *IEEE Trans. Contr. Sys. Tech.*, Vol. 1, pp. 290-293, 1994.

I.73 S. Rern, P. T. Kabamba, and D. S. Bernstein, "A Guardian Map Approach to Robust Stability of Linear Systems with Constant Real Parameter Uncertainty," *IEEE Trans. Autom. Contr.*, Vol. 39, pp. 162-164, 1994.

I.74 W. M. Haddad, H.-H. Huang, and D. S. Bernstein, "Sampled-Data Observers With Generalized Holds for Unstable Plants," *IEEE Trans. Autom. Contr.*, Vol. 39, pp. 229-234, 1994.

I.75 W. M. Haddad and D. S. Bernstein, "Explicit Construction of Quadratic Lyapunov Functions for the Small Gain, Positivity, Circle, and Popov Theorems and Their Application to Robust Stability, Part II: Discrete-Time Theory," *Int. J. Robust and Nonlinear Control*, Vol. 4, pp. 249-265, 1994.

I.76 W. M. Haddad, D. S. Bernstein, and Y. W. Wang, "Dissipative H_2/H_∞ Controller Synthesis," *IEEE Trans. Autom. Contr.*, Vol. 39, pp. 827-831, 1994.

I.77 W. M. Haddad and D. S. Bernstein, "Parameter-Dependent Lyapunov Functions and the Discrete-Time Popov Criterion for Robust Analysis," *Automatica*, Vol. 30, pp. 1015-1021, 1994.

I.78 D. S. Bernstein and W. M. Haddad, "Nonlinear Controllers for Positive Real Systems with Arbitrary Input Nonlinearities," *IEEE Trans. Autom. Contr.*, Vol. 39, pp. 1513-1517, 1994.

I.79 J. H. Friedman and D. S. Bernstein, "Maximum Entropy Controller Synthesis for Colocated and Noncolocated Systems," *AIAA J. Guid. Contr. Dyn.*, Vol. 17, pp. 859-862, 1994.

I.80 W. M. Haddad, D. S. Bernstein, and V. Kapila, "Reduced-Order Multirate Estimation," *AIAA J. Guid. Contr. Dyn.*, Vol. 17, pp. 712-721, 1994.

I.81 W. M. Haddad, J. P. How, S. R. Hall, and D. S. Bernstein, "Extensions of Mixed-μ Bounds to Monotonic and Odd Monotonic Nonlinearities Using Absolute Stability Theory," *Int. J. Contr.*, to appear.

I.82 Y. W. Wang and D. S. Bernstein, "L_2 Controller Synthesis with L_∞-Bounded Closed-Loop Impulse Response," *Int. J. Contr.*, to appear.

I.83 Y. W. Wang and D. S. Bernstein, "H_2-Suboptimal Stable Stabilization," *Automatica*, Vol. 30, 1994, to appear.

I.84 W. M. Haddad and D. S. Bernstein, "The Multivariable Parabola Criterion for Robust Controller Synthesis: A Riccati Equation Approach," *J. Math. Sys. Est. Contr.*, to appear.

I.85 D. S. Bernstein, "Optimal Nonlinear, But Continuous, Feedback Control of Systems with Saturating Actuators," *Int. J. Contr.*, to appear.

I.86 Y. W. Wang, W. M. Haddad, and D. S. Bernstein, "Stable Stabilization With H_2 and H_∞ Performance Constraints," *J. Math. Sys. Est. Contr.*, to appear.

I.87 Y. W. Wang, W. M. Haddad, and D. S. Bernstein, "Robust Strong Stabilization via Modified Popov Controller Synthesis," *IEEE Trans. Autom. Contr.*, to appear.

I.88 Y. Kishimoto and D. S. Bernstein, "Thermodynamic Modeling of Interconnected Systems I: Conservative Coupling," *J. Sound Vibr.*, to appear.

I.89 Y. Kishimoto and D. S. Bernstein, "Thermodynamic Modeling of Interconnected Systems II: Dissipative Coupling," *J. Sound Vibr.*, to appear.

I.90 F. Tyan, S. R. Hall, and D. S. Bernstein, "A Double-Commutator Guaranteed Cost Bound for Robust Stability and Performance," *Sys. Contr. Lett.*, to appear.

I.91 W. M. Haddad and D. S. Bernstein, "Parameter-Dependent Lyapunov Functions and the Popov Criterion in Robust Analysis and Synthesis," *IEEE Trans. Autom. Contr.*, to appear.

I.92 C.-J. Wan and D. S. Bernstein, "Optimal Nonlinear Feedback Control with Global Stabilization," *Dynamics and Control*, to appear.

I.93 W. M. Haddad and D. S. Bernstein, "The Octomorphic Criterion for Multiple-Block-Structured Real Parameter Uncertainty: Real-μ Bounds Without Circles and D,N-Scales," *Sys. Contr. Lett.*, to appear.

I.94 S. L. Osburn and D. S. Bernstein, "An Exact Treatment of the Achievable Closed-Loop H_2 Performance of Sampled-Data Controllers: From Continuous-Time to Open-Loop," *Automatica*, to appear.

I.95 Y. Kishimoto, D. S. Bernstein, and S. R. Hall, "Energy Flow Modeling of Interconnected Structures: A Deterministic Foundation for Statistical Energy Analysis," *J. Sound Vibr.*, to appear.

I.96 D. S. Bernstein and S. P. Bhat, "Lyapunov Stability, Semistability, and Asymptotic Stability of Matrix Second-Order Systems," *ASME Trans. J. Vibr. Acoustics*, to appear.

I.97 C.-J. Wan, V. T. Coppola, and D. S. Bernstein, "Global Asymptotic Stabilization of a Spinning Top," *Optimal Contr. Appl. Meth.*, to appear.

I.98 Y. Ge, L. T. Watson, E. G. Collins, Jr., and D. S. Bernstein, "Globally Convergent Homotopy Algorithms for the Combined H_2/H_∞ Model Reduction Problem," submitted to *Math. Sys. Est. Contr.*

I.99 Y. Kishimoto, D. S. Bernstein, and S. R. Hall, "Dissipative Control of Energy Flow in Interconnected Systems, I. Modal Subsystems," submitted to *Contr. Theory Adv. Tech.*

I.100 Y. Kishimoto, D. S. Bernstein, and S. R. Hall, "Dissipative Control of Energy Flow in Interconnected Systems, II. Structural Subsystems," submitted to *Contr. Theory Adv. Tech.*

I.101 C.-J. Wan, P. Tsiotras, V. T. Coppola, and D. S. Bernstein, "Global Stabilization of the Spinning Top Using Stereographic Projection," submitted to *Dynamics and Control.*

I.102 S. L. Osburn and D. S. Bernstein, "A Generalized Eigenvalue Problem for Solving the Discrete-Time Riccati Equation with Singular Dynamics and Singular Measurement Noise," submitted to *IEEE Trans. Autom. Contr.*

I.103 A. G. Sparks and D. S. Bernstein, "Optimal Tradeoff Between H_2 Performance and Tracking Accuracy in Servocompensator Synthesis," submitted to *AIAA J. Guid. Contr. Dyn.*

I.104 F. Tyan and D. S. Bernstein, "Antiwindup Compensator Synthesis for Systems with Saturating Actuators," *Int. J. Robust and Nonlinear Control*, to appear.

I.105 A. G. Sparks and D. S. Bernstein, "Optimal Rejection of Stochastic and Deterministic Disturbances," submitted to *ASME J. Dyn. Sys. Meas. Contr.*

I.106 A. G. Sparks and D. S. Bernstein, "Asymptotic Regulation with H_2 Disturbance Rejection," submitted to *Int. J. Contr.*

I.107 D. S. Bernstein, W. M. Haddad, and A. G. Sparks, "A Simplified Proof of the Popov Criterion and an Upper Bound for the Structured Singular Value with Real Parameter Uncertainty," submitted to *Automatica.*

I.108 G. Yuzhen, L. T. Watson, E. G. Collins, and D. S. Bernstein, "Probability-One Homotopy Algorithms for Full and Reduced Order H^2/H^∞ Controller Synthesis," submitted to *Optimal Contr. Appl. Meth.*

I.109 C.-J. Wan, D. S. Bernstein, and V. T. Coppola, "Global Stabilization of the Oscillating Eccentric Rotor," submitted to *Nonlinear Dynamics.*

I.110 S. L. Osburn and D. S. Bernstein, "An Empirical Investigation of the Achievable Performance of Sampled-Data Controllers with Exponential Sampling and Reconstruction," submitted to *IEEE Trans. Contr. Sys. Tech.*

I.111 S. P. Bhat and D. S. Bernstein, "Second-Order Systems with Singular Mass Matrix and an Extension of Guyan Reduction," submitted to *SIAM J. Matrix Anal. Appl.*

I.112 J. Hong, J. C. Akers, R. Venugopal, M.-N. Lee, A. G. Sparks, P. D. Washabaugh, and D. S. Bernstein, "Modeling, Identification, and Feedback Control of Noise in an Acoustic Duct," submitted to *IEEE Trans. Contr. Sys. Tech.*

I.113 K.-Y. Lum and D. S. Bernstein, "Global Stabilization of the Spinning Top with Mass Imbalance," submitted to *Dynamics and Stability.*

I.114 K.-Y. Lum, S. P. Bhat, V. T. Coppola and D. S. Bernstein, "Adaptive Virtual Balancing for a Magnetic Rotor with Unknown Mass Imbalance," submitted to *ASME Trans. J. Vibr. Acoustics.*

I.115 A. G. Sparks and D. S. Bernstein, "Reliable State Space Upper Bounds for the Peak Structured Singular Value," submitted to *IEEE Trans. Autom. Contr.*

I.116 A. G. Sparks and D. S. Bernstein, "Real Structured Singular Value Synthesis Using the Scaled Popov Criterion," submitted to *Int. J. Contr.*

II. Conference Papers and Technical Reports

II.1 D. C. Hyland and D. S. Bernstein. "Explicit Optimality Conditions for Fixed–Order Dynamic Compensation," *Proc. IEEE Conf. Dec. Contr.*, pp. 161-165, San Antonio, TX, December 1983.

II.2 D. S. Bernstein and D. C. Hyland, "The Optimal Projection Equations for Fixed-Order Dynamic Compensation of Distributed Parameter Systems," *Proc. AIAA Dynamics Specialists Conf.*, pp. 396–400, Palm Springs, CA, May 1984.

II.3 D. C. Hyland and D. S. Bernstein, "The Optimal Projection Approach to Model Reduction and the Relationship Between the Methods of Wilson and Moore," *Proc. IEEE Conf. Dec. Contr.*, pp. 120–126, Las Vegas, NV, December 1984.

II.4 D. S. Bernstein and D. C. Hyland, "The Optimal Projection Approach to Designing Optimal Finite-Dimensional Controllers for Distributed Parameter Systems," *Proc. IEEE Conf. Dec. Contr.*, pp. 556–560, Las Vegas, NV, December 1984.

II.5 L. D. Davis, D. C. Hyland, and D. S. Bernstein, "Application of the Maximum Entropy Design Approach to the Spacecraft Control Laboratory Experiment (SCOLE)," Final Report, NASA Langley, January 1985.

II.6 D. S. Bernstein and D. C. Hyland, "The Optimal Projection Equations for Reduced-Order State Estimation," *Proc. Amer. Contr. Conf.*, pp. 164-167, Boston, MA, June 1985.

II.7 D. S. Bernstein and D. C. Hyland, "Optimal Projection/Maximum Entropy Stochastic Modelling and Reduced-Order Design Synthesis," *Proc. IFAC Workshop on Model Error Concepts and Compensation*, Boston, MA, June 1985, R. E. Skelton and D. H. Owens, Eds., pp. 47–54, Pergamon Press, Oxford, 1986.

II.8 D. S. Bernstein, "The Optimal Projection Equations for Fixed-Structure Decentralized Dynamic Compensation," *Proc. IEEE Conf. Dec. Contr.*, pp. 104–107, Fort Lauderdale, FL, December 1985.

II.9 D. S. Bernstein, L. D. Davis, S. W. Greeley, and D. C. Hyland, "The Optimal Projection Equations for Reduced-Order, Discrete-Time Modelling, Estimation and Control," *Proc. IEEE Conf. Dec. Contr.*, pp. 573–578, Fort Lauderdale, FL, December 1985.

II.10 D. S. Bernstein and D. C. Hyland, "The Optimal Projection/Maximum Entropy Approach to Designing Low-Order, Robust Controllers for Flexible Structures," *Proc. IEEE Conf. Dec. Contr.*, pp. 745–752, Fort Lauderdale, FL, December 1985.

II.11 D. S. Bernstein, L. D. Davis, S. W. Greeley, and D. C. Hyland, "Numerical Solution of the Optimal Projection/Maximum Entropy Design Equations for Low-Order, Robust Controller Design," *Proc. IEEE Conf. Dec. Contr.*, pp. 1795-1798, Fort Lauderdale, FL, December 1985.

II.12 D. S Bernstein, L. D. Davis, and S. W. Greeley, "The Optimal Projection Equations for Fixed-Order, Sampled-Data Dynamic Compensation with Computation Delay," *Proc. Amer. Contr. Conf.*, pp. 1590–1597, Seattle, WA, June 1986.

II.13 D. S. Bernstein and S. W. Greeley, "Robust Output-Feedback Stabilization: Deterministic and Stochastic Perspectives," *Proc. Amer. Contr. Conf.*, pp. 1818–1826, Seattle, WA, June 1986.

II.14 D. C. Hyland and D. S. Bernstein, "MEOP Control Design Synthesis: Optimal Quantification of the Major Design Tradeoffs," in *Structural Dynamics and Control Interaction of Flexible Structures*, Part 2, pp. 1033-1070, NASA Conf. Publ. 2467, 1987.

II.15 W. M. Haddad and D. S. Bernstein, "The Optimal Projection Equations for Reduced-Order State Estimation: The Singular Measurement Noise Case," *Proc. Amer. Contr. Conf.*, pp. 779–785, Minneapolis, MN, June 1987.

II.16 D. C. Hyland and D. S. Bernstein, "The Majorant Lyapunov Equation: A Nonnegative Matrix Equation for Robust Stability and Performance of Large Scale Systems," *Proc. Amer. Contr. Conf.*, pp. 910–917, Minneapolis, MN, June 1987.

II.17 D. S. Bernstein, "Sequential Design of Decentralized Dynamic Compensators Using the Optimal Projection Equations: An Illustrative Example Involving Interconnected Flexible Beams," *Proc. Amer. Contr. Conf.*, pp. 986–989, Minneapolis, MN, June 1987.

II.18 D. S. Bernstein, "The Optimal Projection Equations For Nonstrictly Proper Fixed-Order Dynamic Compensation," *Proc. Amer. Contr. Conf.*, pp. 1991–1996, Minneapolis, MN, June 1987.

II.19 D. S. Bernstein and W. M. Haddad, "Optimal Output Feedback for Nonzero Set Point Regulation," *Proc. Amer. Contr. Conf.*, pp. 1997-2003, Minneapolis, MN, June 1987.

II.20 W. M. Haddad and D. S. Bernstein, "The Unified Optimal Projection Equations for Simultaneous Reduced-Order, Robust Modeling, Estimation and Control," *Proc. IEEE Conf. Dec. Contr.*, pp. 449–454, Los Angeles, CA, December 1987.

II.21 D. S. Bernstein and W. M. Haddad, "The Optimal Projection Equations with Petersen-Hollot Bounds: Robust Controller Synthesis with Guaranteed Structured Stability Radius," *Proc. IEEE Conf. Dec. Contr.*, pp. 1308–1318, Los Angeles, CA, December 1987.

II.22 D. S. Bernstein, "Commuting Matrix Exponentials," Problem 88–1, *SIAM Review*, Vol. 30, p. 123, 1988. (Also appears in *Problems in Applied Mathematics*, pp. 296–298, M. S. Klamkin, Ed., SIAM, 1990.)

II.23 D. C. Hyland, D. S. Bernstein, and E. G. Collins, Jr., "Maximum Entropy/Optimal Projection Design Synthesis for Decentralized Control of Large Space Structures," Final Report, Air Force Office of Scientific Research, Bolling AFB, Washington, DC, May 1988.

II.24 D. S. Bernstein and W. M. Haddad, "LQG Control with an H_∞ Performance Bound: A Riccati Equation Approach," *Proc. Amer. Contr. Conf.*, pp. 796–802, Atlanta, GA, June 1988.

II.25 D. S. Bernstein and W. M. Haddad, "Robust Stability and Performance for Fixed-Order Dynamic Compensation via the Optimal Projection Equations with Guaranteed Cost Bounds," *Proc. Amer. Contr. Conf.*, pp. 2471–2476, Atlanta, GA, June 1988.

II.26 D. S. Bernstein, "OPUS: Optimal Projection for Uncertain Systems," Final Report, Air Force Office of Scientific Research, Bolling AFB, Washington, DC, October 1988.

II.27 A. N. Madiwale, W. M. Haddad, and D. S. Bernstein, "Robust H_∞ Control Design for Systems with Parameter Uncertainty," *Proc. IEEE Conf. Dec. Contr.*, pp. 965–972, Austin, TX, December 1988. (Also appears in *Recent Advances in Robust Control*, pp. 237–244, P. Dorato and R. K. Yedavalli, Eds., IEEE Press, 1990.)

II.28 D. S. Bernstein and W. M. Haddad, "Robust Decentralized Output Feedback: The Static Controller Case," *Proc. IEEE Conf. Dec. Contr.*, pp. 1009–1013, Austin, TX, December 1988.

II.29 D. S. Bernstein and I. G. Rosen, "An Approximation Technique for Computing Optimal Fixed-Order Controllers for Infinite-Dimensional Systems," *Proc. IEEE Conf. Dec. Contr.*, pp. 2023–2028, Austin, TX, December 1988.

II.30 D. S. Bernstein and W. M. Haddad, "Robust Stability and Performance Analysis for State Space Systems via Quadratic Lyapunov Bounds," *Proc. IEEE Conf. Dec. Contr.*, pp. 2182–2187, Austin, TX, December 1988.

II.31 D. S. Bernstein and W. M. Haddad, "Optimal Reduced-Order State Estimation for Unstable Plants," *Proc. IEEE Conf. Dec. Contr.*, pp. 2364–2366, Austin, TX, December 1988.

II.32 W. M. Haddad and D. S. Bernstein, "Complete Solution to the Nonsingular H_2/H_∞ Four Block Problem," *Proc. Amer. Contr. Conf.*, pp. 187–192, Pittsburgh, PA, June 1989.

II.33 D. S. Bernstein and W. M. Haddad, "Steady-State Kalman Filtering with an H_∞ Error Bound," *Proc. Amer. Contr. Conf.*, pp. 847–852, Pittsburgh, PA, June 1989.

II.34 C. N. Nett, D. S. Bernstein, and W. M. Haddad, "Minimal Complexity Control Law Synthesis, Part 1: Problem Formulation and Reduction to Optimal Static Output Feedback," *Proc. Amer. Contr. Conf.*, pp. 2056–2064, Pittsburgh, PA, June 1989.

II.35 Y. Halevi, W. M. Haddad, and D. S. Bernstein, "A Riccati Equation Approach to the Singular LQG Problem," *Proc. Amer. Contr. Conf.*, pp. 2077–2078, Pittsburgh, PA, June 1989.

II.36 D. S. Bernstein, W. M. Haddad, and C. N. Nett, "Minimal Complexity Control Law Synthesis, Part 2: Problem Solution via H_2/H_∞ Optimal Static Output Feedback," *Proc. Amer. Contr. Conf.*, pp. 2506–2511, Pittsburgh, PA, June 1989. (Also appears in *Recent Advances in Robust Control*, pp. 288–293, P. Dorato and R. K. Yedavalli, Eds., IEEE Press, 1990.)

II.37 W. M. Haddad and D. S. Bernstein, "Combined H_2/H_∞ Model Reduction," *Proc. Amer. Contr. Conf.*, pp. 2660–2665, Pittsburgh, PA, June 1989.

II.38 D. S. Bernstein and C. V. Hollot, "Robust Stability for Sampled-Data Control Systems," *Proc. Amer. Contr. Conf.*, pp. 2834–2839, Pittsburgh, PA, June 1989. (Also appears in *Recent Advances in Robust Control*, pp. 164–169, P. Dorato and R. K. Yedavalli, Eds., IEEE Press, 1990.)

II.39 W. M. Haddad and D. S. Bernstein, "Optimal Reduced-Order Observer-Estimators," *Proc. AIAA Guid. Nav. Contr. Conf.*, pp. 907–1006, Boston, MA, August 1989.

II.40 W. M. Haddad and D. S. Bernstein, "Generalized Riccati Equations for the Full- and Reduced-Order Mixed-Norm H_2/H_∞ Standard Problem," *Proc. IEEE Conf. Dec. Contr.*, pp. 397–402,

Tampa, FL, December 1989.

II.41 W. M. Haddad, D. S. Bernstein, and C. N. Nett, "Decentralized H_2/H_∞ Controller Design: The Discrete-Time Case," *Proc. IEEE Conf. Dec. Contr.*, pp. 932–933, Tampa, FL, December 1989.

II.42 W. M. Haddad and D. S. Bernstein, "On the Gap Between H_2 and Entropy Performance Measures in H_∞ Control," *Proc. IEEE Conf. Dec. Contr.*, pp. 1506–1507, Tampa, FL, December 1989.

II.43 W. M. Haddad and D. S. Bernstein, "Optimal Reduced-Order Observer-Estimators," *Proc. IEEE Conf. Dec. Contr.*, pp. 2412–2417, Tampa, FL, December 1989.

II.44 W. M. Haddad and D. S. Bernstein, "Regional Pole Placement via Optimal Static and Dynamic Output Feedback," *Proc. Amer. Contr. Conf.*, pp. 130–135, San Diego, CA, May 1990.

II.45 B. Wie and D. S. Bernstein, "A Benchmark Problem for Robust Control Design," *Proc. Amer. Contr. Conf.*, pp. 961–962, San Diego, CA, May 1990.

II.46 E. G. Collins, Jr., and D. S. Bernstein, "Robust Control Design for a Benchmark Problem Using a Structured Covariance Approach," *Proc. Amer. Contr. Conf.*, pp. 970–971, San Diego, CA, May 1990.

II.47 D. C. Hyland and D. S. Bernstein, "Power Flow, Energy Balance, and Statistical Energy Analysis for Large Scale, Interconnected Systems," *Proc. Amer. Contr. Conf.*, pp. 1929–1934, San Diego, CA, May 1990.

II.48 M. Jacobus, M. Jamshidi, C. Abdallah, P. Dorato, and D. S. Bernstein, "Suboptimal Strong Stabilization Using Fixed-Order Dynamic Compensation," *Proc. Amer. Contr. Conf.*, pp. 2659–2660, San Diego, CA, May 1990.

II.49 D. S. Bernstein and V. Zeidan, "The Singular Linear-Quadratic Regulator Problem and the Goh-Riccati Equation," *Proc. IEEE Conf. Dec. Contr.*, pp. 334–339, Honolulu, HI, December 1990.

II.50 D. S. Bernstein, E. G. Collins, Jr., and D. C. Hyland, "Real Parameter Uncertainty and Phase Information in the Robust Control of Flexible Structures," *Proc. IEEE Conf. Dec. Contr.*, pp. 379–380, Honolulu, HI, December 1990.

II.51 D. S. Bernstein and W. M. Haddad, "Robust Controller Synthesis Using Kharitonov's Theorem," *Proc. IEEE Conf. Dec. Contr.*, pp. 1222–1223, Honolulu, HI, December 1990.

II.52 W. M. Haddad and D. S. Bernstein, "Robust Stabilization with Positive Real Uncertainty: Beyond the Small Gain Theorem," *Proc. IEEE Conf. Dec. Contr.*, pp. 2054–2059, Honolulu, HI, December 1990.

II.53 W. M. Haddad, D. S. Bernstein, and H.-H. Huang, "Reduced-Order Multirate Estimation for Stable and Unstable Plants," *Proc. IEEE Conf. Dec. Contr.*, pp. 2892–2897, Honolulu, HI, December 1990.

II.54 M. Jacobus, M. Jamshidi, C. Abdallah, P. Dorato, and D.S. Bernstein, "Design of Strictly Positive Real, Fixed-Order Dynamic Compensators," *Proc. IEEE Conf. Dec. Contr.*, pp. 3492–3495, Honolulu, HI, December 1990.

II.55 D. Mustafa and D. S. Bernstein, "LQG Bounds in Discrete-Time H_2/H_∞ Control," *Proc. Symp. Robust Control System Design Using H_∞ and Related Methods*, University of Cambridge, March 1991.

II.56 W. M. Haddad and D.S. Bernstein, "Explicit Construction of Quadratic Lyapunov Functions for the Small Gain, Positivity, Circle, and Popov Theorems and Their Application to Robust Stability," in *Control of Uncertain Dynamic Systems*, S.P. Bhattacharyya and L.H. Keel, Eds., pp. 149-173, Proc. Int. Workshop on Robust Control, March 1991, CRC Press, Boca Raton, FL, 1991.

II.57 D.S. Bernstein and D.C. Hyland, "Compartmental Analysis and Power Flow Analysis for State Space Systems," in *Control of Uncertain Dynamic Systems*, S.P. Bhattacharyya and L.H. Keel, Eds., pp. 175-202, Proc. Int. Workshop on Robust Control, March 1991, CRC Press, Boca Raton, FL, 1991.

II.58 D. S. Bernstein, "Nonquadratic Cost and Nonlinear Feedback Control," *Proc. Amer. Contr. Conf.*, pp. 533–538, Boston, MA, June 1991.

II.59 D. R. Seinfeld, W. M. Haddad, D. S. Bernstein, and C. N. Nett, "H_2/H_∞ Controller Synthesis: Illustrative Numerical Results via Quasi-Newton Methods," *Proc. Amer. Contr. Conf.*, pp. 1155–1156, Boston, MA, June 1991.

II.60 W. M. Haddad, D. S. Bernstein, and D. Mustafa, "Mixed-Norm H_2/H_∞ Regulation and Estimation: The Discrete-Time Case," *Proc. Amer. Contr. Conf.*, pp. 1159–1164, Boston, MA, June 1991.

II.61 B. Wie and D. S. Bernstein, "A Benchmark Problem for Robust Control Design," *Proc. Amer. Contr. Conf.*, pp. 1926-1927, Boston, MA, June 1991.

II.62 E. G. Collins, Jr., J. A. King, and D. S. Bernstein, "Robust Control Design for the Benchmark Problem Using the Maximum Entropy Approach," *Proc. Amer. Contr. Conf.*, pp. 1935–1936, Boston, MA, June 1991.

II.63 S. R. Hall, D. MacMartin, and D. S. Bernstein, "Multi-Model Fixed-Order Estimation and Control," *Proc. Amer. Contr. Conf.*, pp. 2113–2118, Boston, MA, June 1991.

II.64 W. M. Haddad and D. S. Bernstein, "A New Approach to Disturbance Accommodation and Servocompensator Design," *Proc. Amer. Contr. Conf.*, pp. 2220–2221, Boston, MA, June 1991.

II.65 W. M. Haddad and D. S. Bernstein, "Robust Stabilization with Positive Real Uncertainty: Beyond the Small Gain Theorem," *Proc. Amer. Contr. Conf.*, pp. 2725–2730, Boston, MA, June 1991.

II.66 D. S. Bernstein, W. M. Haddad, and D. C. Hyland, "Small Gain Versus Positive Real Modeling of Real Parameter Uncertainty," *Proc. IEEE Conf. Dec. Contr.*, pp. 539-540, Brighton, U.K., December 1991.

II.67 D. S. Bernstein and D. C. Hyland, "Compartmental Modeling and Second-Moment Analysis of State Space systems," *Proc. IEEE Conf. Dec. Contr.*, pp. 1607-1612, Brighton, U.K., December 1991.

II.68 W. M. Haddad and D. S. Bernstein, "Parameter-Dependent Lyapunov Functions, Constant Real Parameter Uncertainty, and the Popov Criterion in Robust Analysis and Synthesis," *Proc. IEEE Conf. Dec. Contr.*, pp. 2274-2279, 2632-2633, Brighton, U.K., December 1991.

II.69 W. M. Haddad and D. S. Bernstein, "Explicit Construction of Quadratic Lyapunov Functions for the Small Gain, Positivity, Circle, and Popov Theorems and Their Application to Robust Stability," *Proc. IEEE Conf. Dec. Contr.*, pp. 2618-2623, Brighton, U.K., December 1991.

II.70 W. M. Haddad, H.-H. Huang, and D. S. Bernstein, "Robust Stability and Performance via Fixed-Order Dynamic Compensation: The Discrete-Time Case," *Proc. Amer. Contr. Conf.*, pp. 66-67, Chicago, IL, June 1992.

II.71 D. S. Bernstein and W. M. Haddad, "Is There More to Robust Control Theory Than Small Gain?," *Proc. Amer. Contr. Conf.*, pp. 83-84, Chicago, IL, June 1992.

II.72 W. M. Haddad and D. S. Bernstein, "Parameter-Dependent Lyapunov Functions and the Discrete-Time Popov Criterion for Robust Analysis and Synthesis," *Proc. Amer. Contr. Conf.*, pp. 594-598, Chicago, IL, June 1992.

II.73 B. Wie and D. S. Bernstein, "Benchmark Problems for Robust Control Design," *Proc. Amer. Contr. Conf.*, pp. 2047-2048, Chicago, IL, June 1992.

II.74 E. G. Collins, Jr., W. M. Haddad, and D. S. Bernstein, "Small Gain, Circle, Positivity, and Popov Analysis of a Maximum Entropy Controller for a Benchmark Problem," *Proc. Amer. Contr. Conf.*, pp. 2425-2426, Chicago, IL, June 1992.

II.75 D. S. Bernstein, W. M. Haddad, D. C. Hyland, and F. Tyan, "Maximum Entropy-Type Lyapunov Functions for Robust Stability and Performance Analysis," *Proc. Amer. Contr. Conf.*, pp. 2639-2643, Chicago, IL, June 1992.

II.76 S. Rern, P. T. Kabamba, and D. S. Bernstein, "A Guardian Map Approach to Robust Stability of Linear Systems with Constant Real Parameter Uncertainty," *Proc. Amer. Contr. Conf.*, pp. 2649-2652, Chicago, IL, June 1992.

II.77 W. M. Haddad and D. S. Bernstein, "The Parabola Test: A Unified Extension of the Circle and Popov Criteria," *Proc. Amer. Contr. Conf.*, pp. 2662-2663, Chicago, IL, June 1992.

II.78 Y. W. Wang and D. S. Bernstein, "Controller Design With Regional Pole Constraints: Hyperbolic and Horizontal Strip Regions," *Proc. AIAA Guid. Nav. Contr. Conf.*, Hilton Head, SC, August 1992.

II.79 D. Zigic, L. T. Watson, E. G. Collins, Jr., and D. S. Bernstein, "Effect of Initial System on Homotopy Methods for the H_2 Reduced-Order Model Problem," *Proc. IEEE Conf. Contr. Appl.*, pp. 252-257, Dayton, OH, September 1992.

II.80 C.-J. Wan and D. S. Bernstein, "A Family of Optimal Nonlinear Feedback Controllers that

Globally Stabilize Angular Velocity," *Proc. IEEE Conf. Dec. Contr.*, pp. 1143-1148, Tucson, AZ. December 1992.

II.81 S. R. Hall, D. G. MacMartin, and D. S. Bernstein, " Covariance Averaging in the Analysis of Uncertain Systems," *IEEE Conf. Dec. Contr.*, pp. 1842-1849, Tucson, AZ, December 1992.

II.82 W. M. Haddad, H.-H. Huang, and D. S. Bernstein, "Sampled-Data Observers with Generalized Holds for Unstable Plants," *Proc. IEEE Conf. Dec. Contr.*, pp. 1961-1965, Tucson, AZ, December 1992.

II.83 F. Tyan, D. S. Bernstein, W. M. Haddad, and D. C. Hyland, "Asymptotic Analysis of the Maximum Entropy Lyapunov Equation for Robust Stability and Performance Analysis," *Proc. IEEE Conf. Dec. Contr.*, pp. 2008-2009, Tucson, AZ, December 1992.

II.84 W. M. Haddad and D. S. Bernstein, "New Absolute Stability Criteria for Robust Stability and Performance with Locally Slope-Restricted Monotonic Nonlinearities," *Proc. IEEE Conf. Dec. Contr.*, pp. 2611-2616, Tucson, AZ, December 1992.

II.85 W. M. Haddad, J. P. How, S. R. Hall, and D. S. Bernstein, "Extensions of Mixed-μ Bounds to Monotonic and Odd Monotonic Nonlinearities Using Absolute Stability Theory," *Proc. IEEE Conf. Dec. Contr.*, pp. 2813-2823, Tucson, AZ, December 1992.

II.86 Y. W. Wang and D. S. Bernstein, "H_2/H_∞ Optimal Control Synthesis with Regional Pole Constraints," *Proc. IEEE Conf. Dec. Contr.*, pp. 3711-3716, Tucson, AZ, December 1992.

II.87 J. H. Friedman and D. S. Bernstein, "Maximum Entropy Controller Synthesis for Colocated and Noncolocated Systems," *Proc. 2nd Conference on Recent Advances in Active Control of Sound and Vibration*, R. A. Burdisso, Ed., pp. 327-338, Blacksburg, VA, April 1993.

II.88 W. M. Haddad, D. S. Bernstein, and Y. W. Wang, "Dissipative H_2/H_∞ Controller Synthesis," *Proc. Amer. Contr. Conf.*, pp. 243-244, San Francisco, CA, June 1993.

II.89 D. S. Bernstein and W. M. Haddad, "Nonlinear Controllers for Positive Real Systems with Arbitrary Input Nonlinearities," *Proc. Amer. Contr. Conf.*, pp. 832-836, San Francisco, CA, June 1993.

II.90 J. H. Friedman and D. S. Bernstein, "Maximum Entropy Controller Synthesis for Colocated and Noncolocated Systems," *Proc. Amer. Contr. Conf.*, pp. 1015-1019, San Francisco, CA, June 1993.

II.91 Y. Kishimoto and D. S. Bernstein, "Thermodynamic Modeling for Interconnected Systems: Conservative Coupling," *Proc. Amer. Contr. Conf.*, pp. 2050-2054, San Francisco, CA, June 1993.

II.92 W. M. Haddad and D. S. Bernstein, "Off-Axis Absolute Stability Criteria and μ-Bounds Involving Non-Positive Real Plant-Dependent Multipliers for Robust Stability and Performance with Locally Slope-Restricted Monotonic Nonlinearities," *Proc. Amer. Contr. Conf.*, pp. 2790-2794, San Francisco, CA, June 1993.

II.93 Y. W. Wang and D. S. Bernstein, "L_2 Controller Synthesis With L_∞-Bounded Closed-Loop Impulse Response," *Proc. Amer. Contr. Conf.*, pp. 3169-3173, San Francisco, CA, June 1993.

II.94 Y. Kishimoto, D. S. Bernstein, and S. R. Hall, "Dissipative Control of Energy Flow in Interconnected Systems," *Proc. AIAA Guid. Navig. Contr. Conf.*, pp. 657-666, Monterey, CA, August 1993.

II.95 S. L. Osburn and D. S. Bernstein, "An Exact Treatment of the Achievable Closed-Loop H_2 Performance of Sampled-Data Controllers: From Continuous-Time to Open-Loop," *Proc. IEEE Conf. Dec. Contr.*, pp. 325-330, San Antonio, TX, December 1993.

II.96 Y. W. Wang and D. S. Bernstein, "H_2-Suboptimal Stable Stabilization," *Proc. IEEE Conf. Dec. Contr.*, pp. 1828-1829, San Antonio, TX, December 1993.

II.97 W. M. Haddad and D. S. Bernstein, "The Octomorphic Criterion for Multiple-Block-Structured Real Parameter Uncertainty: Real-μ Bounds Without Circles and D,N-Scales," *Proc. IEEE Conf. Dec. Contr.*, pp. 1984-1989, San Antonio, TX, December 1993.

II.98 D. S. Bernstein, "Optimal Nonlinear, But Continuous, Feedback Control of Systems with Saturating Actuators," *Proc. IEEE Conf. Dec. Contr.*, pp. 2533-2537, San Antonio, TX, December 1993.

II.99 C.-J. Wan and D. S. Bernstein, "Rotational Stabilization of a Rigid Body Using Two Torque Actuators," *Proc. IEEE Conf. Dec. Contr.*, pp. 3111-3116, San Antonio, TX, December 1993.

II.100 C.-J. Wan, V. T. Coppola, and D. S. Bernstein, "A Lyapunov Function for the Energy-Casimir Method," *Proc. IEEE Conf. Dec. Contr.*, pp. 3122-3123, San Antonio, TX, December 1993.

II.101 C.-J. Wan, P. Tsiotras, V. T. Coppola, and D. S. Bernstein, "Global Asymptotic Stabilization of the Spinning Top With Torque Actuators Using Stereographic Projection," *Proc. Amer. Contr. Conf.*, pp. 536-540, Baltimore, MD, June 1994.

II.102 C.-J. Wan, V. T. Coppola, and D. S. Bernstein, "Global Asymptotic Stabilization of a Spinning Top," *Proc. Amer. Contr. Conf.*, pp. 541-545, Baltimore, MD, June 1994.

II.103 S. L. Osburn and D. S. Bernstein, "A Generalized Eigenvalue Problem for Solving the Discrete-Time Riccati Equation with Singular Dynamics and Singular Measurement Noise," *Proc. Amer. Contr. Conf.*, pp. 1155-1156, Baltimore, MD, June 1994.

II.104 Y. Kishimoto, D. S. Bernstein, and S. R. Hall, "Energy Flow Control of Interconnected Systems," *Proc. Amer. Contr. Conf.*, pp. 1831-1835, Baltimore, MD, June 1994.

II.105 Y. Ge, L. T. Watson, R. S. Erwin, and D. S. Bernstein, "Globally Convergent Homotopy Algorithms for Full-order LQG Control with an H_∞ Performance Bound," *Proc. Amer. Contr. Conf.*, pp. 1906-1910, Baltimore, MD, June 1994.

II.106 S. P. Bhat, and D. S. Bernstein, "Lyapunov Stability, Semistability, and Asymptotic Stability of Matrix Second-Order Systems," *Proc. Amer. Contr. Conf.*, pp. 2355-2359, Baltimore, MD, June 1994.

II.107 A. G. Sparks and D. S. Bernstein, "Optimal Tradeoff Between H_2 Performance and Tracking Accuracy in Servocompensator Synthesis," *Proc. Amer. Contr. Conf.*, pp. 2675-2679, Baltimore, MD, June 1994.

II.108 R. T. Bupp, C.-J.Wan, V. T. Coppola, and D. S. Bernstein, "Design of a Rotational Actuator for Global Stabilization of Translational Motion," *Proc. ASME Winter Meeting*, Chicago, IL, November 1994.

II.109 Y. Ge, L. T. Watson, E. G. Collins, and D. S. Bernstein, "Probability-One Homotopy Algorithms for Full and Reduced Order H^2/H^∞ Controller Synthesis," *Proc. IEEE Conf. Dec. Contr.*, Orlando, FL, December 1994.

II.110 F. Tyan and D. S. Bernstein, "Nonlinear Dynamic Compensator Synthesis for Systems with Saturating Actuators," *Proc. IEEE Conf. Dec. Contr.*, Orlando, FL, December 1994.

II.111 D. S. Bernstein, W. M. Haddad, and A. G. Sparks, "A Simplified Proof of the Popov Criterion and an Upper Bound for the Structured Singular Value with Real Parameter Uncertainty," *Proc. IEEE Conf. Dec. Contr.*, Orlando, FL, December 1994.

II.112 A. G. Sparks and D. S. Bernstein, "The Scaled Popov Criterion and Bounds for the Real Structured Singular Value," *Proc. IEEE Conf. Dec. Contr.*, Orlando, FL, December 1994.

II.113 A. G. Sparks and D. S. Bernstein, "Asymptotic Regulation and H_2 Disturbance Rejection," *Proc. IEEE Conf. Dec. Contr.*, Orlando, FL, December 1994.

II.114 C.-J. Wan, D. S. Bernstein, and V. T. Coppola, "Global Stabilization of the Oscillating Eccentric Rotor," *Proc. IEEE Conf. Dec. Contr.*, Orlando, FL. December 1994.

II.115 R. T. Bupp, D. S. Bernstein and V. T. Coppola, "Global Nonlinear Stabilization of Multi-Modal Translational Motion Using a Rotational Actuator," *Proc. IEEE Conf. Dec. Contr.*, Orlando, FL, December 1994.

II.116 A. G. Sparks and D. S. Bernstein, "Optimal Rejection of Stochastic and Deterministic Disturbances," *Proc. IEEE Conf. Dec. Contr.*, Orlando, FL, December 1994.

II.117 R. T. Bupp, J. R. Corrado, D. S. Bernstein, and V. T. Coppola, "Nonlinear Modification of Positive-Real LQG Compensators for Enhanced Disturbance Rejection and Energy Dissipation," *Proc. Amer. Contr. Conf.*, Seattle, WA, June 1995.

II.118 S. L. Osburn and D. S. Bernstein, "An Empirical Investigation of the Achievable Performance of Sampled-Data Controllers with Exponential Sampling and Reconstruction," *Proc. Amer. Contr. Conf.*, Seattle, WA, June 1995.

II.119 S. L. Osburn and D. S. Bernstein, "Realizing an Averaging-Resetting Analog-to-Digital Converter," *Proc. Amer.Contr. Conf.*, Seattle, WA, June 1995.

II.120 S. L. Osburn and D. S. Bernstein, "Achievable Performance of Sampled-Data Controllers with Input and Output Delays," *Proc. Amer. Contr. Conf.*, Seattle, WA, June 1995.

II.121 S. P. Bhat and D. S. Bernstein, "Second-Order Systems with Singular Mass Matrix and an Extension of Guyan Reduction," *Proc. Amer. Contr. Conf.*, Seattle, WA, June 1995.

II.122 S. P. Bhat and D. S. Bernstein "Lyapunov Analysis of Finite-Time Differential Equations," *Proc. Amer. Contr. Conf.*, Seattle, WA, June 1995.

II.123 A. G. Sparks and D. S. Bernstein, "Reliable State Space Upper Bounds for the Peak Structured Singular Value," *Proc. Amer. Contr. Conf.,* Seattle, WA, June 1995.

II.124 A. G. Sparks and D. S. Bernstein, "Real Structured Singular Value Synthesis Using the Scaled Popov Criterion," *Proc. Amer. Contr. Conf.,* Seattle, WA, June 1995.

II.125 K.-Y. Lum and D. S. Bernstein, "Global Stabilization of the Spinning Top with Mass Imbalance," *Proc. Amer. Contr. Conf.,* Seattle, WA. June 1995.

II.126 K.-Y. Lum, S. P. Bhat, V. T. Coppola and D. S. Bernstein, "Adaptive Virtual Balancing for a Magnetic Rotor with Unknown Mass Imbalance," *Proc. Amer. Contr. Conf.,* Seattle, WA, June 1995.

II.127 J. Hong, J. C. Akers, R. Venugopal, M.-N. Lee, A. G. Sparks, P. D. Washabaugh, and D. S. Bernstein, "Modeling, Identification, and Feedback Control of Noise in an Acoustic Duct," *Proc. Amer. Contr. Conf.,* Seattle, WA, June 1995.

II.128 F. Tyan and D. S. Bernstein, "Dynamic Output Feedback Compensation for Systems with Input Saturation," *Proc. Amer. Contr. Conf.,* Seattle, WA, June 1995.

II.129 J. C. Akers and D. S. Bernstein, "Measurement Noise Error Bounds for the Eigensystem Realization Algorithm," *Proc. Amer. Contr. Conf.,* Seattle, WA, June 1995.

II.130 W. M. Haddad and D. S. Bernstein, "Real-μ Bounds Based on Fixed Shapes in the Nyquist Plane: Parabolas, Cissoids, Octomophs, Nephroids, and Hyperbolas," *Proc. Amer. Contr. Conf.,* Seattle, WA, June 1995.

II.131 W. M. Haddad and D. S. Bernstein, "Generalized Mixed-μ Bounds for Real and Complex Multiple-Block Uncertainty with Internal Matrix Structure," *Proc. Amer. Contr. Conf.,* Seattle, WA, June 1995.

II.132 W. M. Haddad, "Structured Matrix Norms for Robust Stability with Block-Structured Uncertainty," *Proc. Amer. Contr. Conf.,* Seattle, WA, June 1995.

II.133 D. S. Bernstein and W. M. Haddad, *Multivariable Control-System Synthesis: The Fixed-Structure Approach,* in preparation.